

CLAIMS

1. A liquid crystal display device, comprising:
a first substrate, a second substrate, and a liquid
crystal layer provided between the first substrate and the
5 second substrate;

wherein:
a plurality of picture element regions are each defined
by a first electrode provided on one surface of the first
substrate which is closer to the liquid crystal layer and a
10 second electrode provided on the second substrate and
opposing the first electrode with the liquid crystal layer
interposed therebetween;

in each of the plurality of picture element regions, the
first electrode includes a plurality of openings and a solid
15 portion; and the liquid crystal layer is in a vertical
orientation state when no voltage is applied between the
first electrode and the second electrode, and when a voltage
is applied between the first electrode and the second
electrode, forms a plurality of liquid crystal domains each
20 taking a radially-inclined orientation in correspondence with

the plurality of openings and the solid portion by an oblique electric field produced in edge portions of the plurality of openings of the first electrode;

the solid portion of the first electrode includes a plurality of unit solid portions and a plurality of connecting portions each for connecting at least three unit solid portions of the plurality of unit solid portions to one another; and

the second substrate has a first orientation-regulating structure in an area corresponding to each of the plurality of connecting portions, the first orientation-regulating structure exerting an orientation-regulating force for placing liquid crystal molecules in the liquid crystal layer above each of the plurality of connecting portions into a radially-inclined orientation at least in a state where a voltage is applied between the first electrode and the second electrode.

2. The liquid crystal display device of claim 1, wherein the liquid crystal layer forms a liquid crystal domain taking

a radially-inclined orientation in correspondence with each of the plurality of connecting portions by the orientation-regulating force exerted by the first orientation-regulating structure.

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3. The liquid crystal display device of claim 1 or 2, wherein each of the plurality of connecting portions connects four unit solid portions of the plurality of unit solid portions to one another.

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4. The liquid crystal display device of any one of claims 1 through 3, wherein:

each of the unit solid portions has a plurality of corners; and

15 each of the plurality of connecting portions connects adjacent unit solid portions of the plurality of unit solid portions to one another via the plurality of corners.

20 5. The liquid crystal display device of claim 4, wherein the plurality of corners are each acute.

6. The liquid crystal display device of claim 4 or 5,
wherein the plurality of corners are four corners.

5 7. The liquid crystal display device of any one of
claims 1 through 6, wherein the first orientation-regulating
structure exerts the orientation-regulating force even in a
state where no voltage is applied between the first electrode
and the second electrode.

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8. The liquid crystal display device of any one of
claims 1 through 7, wherein the first orientation-regulating
structure includes a protrusion protruding from the second
substrate toward the liquid crystal layer.

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9. The liquid crystal display device of any one of
claims 1 through 7, wherein the first orientation-regulating
structure includes a surface having a horizontal alignment
power which is provided on one surface of the second
substrate which is closer to the liquid crystal layer.

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10. The liquid crystal display device of any one of claims 1 through 7, wherein the first orientation-regulating structure includes a surface which is provided on one surface 5 of the second substrate that is closer to the liquid crystal layer and which inclines the liquid crystal molecules in the liquid crystal layer at an angle smaller than that of the vertical alignment.

10 11. The liquid crystal display device of any one of claims 1 through 6, wherein the first orientation-regulating structure exerts the orientation-regulating force only in a state where a voltage is applied between the first electrode and the second electrode.

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12. The liquid crystal display device of any one of claims 1 through 6 and 11, wherein the first orientation-regulating structure includes an opening provided in the second electrode.

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13. The liquid crystal display device of any one of claims 1 through 12, wherein the second substrate includes a second orientation-regulating structure in an area corresponding to each of the plurality of unit solid portions, the second orientation-regulating structure exerting an orientation-regulating force for the placing liquid crystal molecules in the liquid crystal domain formed in correspondence with each of the plurality of unit solid portions into a radially-inclined orientation at least in a state where a voltage is applied between the first electrode and the second electrode.

14. The liquid crystal display device of claim 13, wherein the second orientation-regulating structure is provided in an area corresponding to a central portion or the vicinity thereof of each of the plurality of unit solid portions.

15. The liquid crystal display device of claim 13 or 14, wherein in the liquid crystal domain formed in correspondence

with each of the plurality of unit solid portions, an orientation-regulating direction provided by the second orientation-regulating structure matches a direction of the radially-inclined orientation provided by the oblique 5 electric field.

16. The liquid crystal display device of any one claims 13 through 15, wherein the second orientation-regulating structure exerts the orientation-regulating force 10 even in a state where no voltage is applied between the first electrode and the second electrode.

17. The liquid crystal display device of any one claims 13 through 16, wherein the second orientation-regulating structure includes a protrusion protruding from 15 the second substrate toward the liquid crystal layer.

18. The liquid crystal display device of any one claims 13 through 16, wherein the second orientation-regulating structure includes a surface having a horizontal 20

alignment power which is provided on one surface of the second substrate which is closer to the liquid crystal layer.

19. The liquid crystal display device of any one of
5 claims 13 through 16, wherein the second orientation-regulating structure includes a surface which is provided on one surface of the second substrate that is closer to the liquid crystal layer and which inclines the liquid crystal molecules in the liquid crystal layer at an angle smaller
10 than that of the vertical alignment.

20. The liquid crystal display device of any one of
claims 13 through 15, wherein the second orientation-regulating structure exerts the orientation-regulating force
15 only in a state where a voltage is applied between the first electrode and the second electrode.

21. The liquid crystal display device of any one of
claims 13 through 15 and 20, wherein the second orientation-regulating structure includes an opening provided in the
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second electrode.

22. The liquid crystal display device of any one of claims 1 through 21, wherein the plurality of unit solid 5 portions each have a shape having rotational symmetry.

23. The liquid crystal display device of any one of claims 1 through 22, wherein the plurality of unit solid portions are each generally star-shaped with four-fold 10 rotational symmetry.

24. The liquid crystal display device of any one of claims 1 through 23, wherein the plurality of unit solid portions have substantially the same shape and substantially 15 the same size as one another, and form at least one unit lattice arranged to have rotational symmetry.

25. The liquid crystal display device of any one of claims 1 through 24, wherein at least some of the plurality 20 of openings have substantially the same shape and

substantially the same size as one another, and form at least one unit lattice arranged to have rotational symmetry.

26. The liquid crystal display device of claim 25,
5 wherein the at least the some of the plurality of openings each have a shape having rotational symmetry.

27. The liquid crystal display device of any one of claims 1 through 26, wherein:

10 the first substrate further includes a switching device provided in correspondence with each of the plurality of picture element regions; and

the first electrode is a picture element electrode provided in each of the plurality of picture element regions
15 and switched by the switching device, and the second electrode is at least one counter electrode opposing the plurality of picture element electrodes.

28. A liquid crystal display device, comprising:

20 a first substrate, a second substrate, and a liquid

crystal layer provided between the first substrate and the second substrate;

wherein:

5 a plurality of picture element regions are each defined by a first electrode provided on one surface of the first substrate which is closer to the liquid crystal layer and a second electrode provided on the second substrate and opposing the first electrode with the liquid crystal layer interposed therebetween;

10 in each of the plurality of picture element regions, the liquid crystal layer is in a vertical orientation state when no voltage is applied between the first electrode and the second electrode; and

15 in each of the plurality of picture element regions, the first electrode includes a plurality of openings, a plurality of generally star-shaped conductive portions each having four acute corners, and a plurality of connecting portions each for connecting four conductive portions of the plurality of conductive portions to one another via the corners; and

20 the second substrate includes a protrusion in an area

corresponding to each of the plurality of connecting portions, the protrusion protruding toward the liquid crystal layer.

5 29. The liquid crystal display device of claim 28, wherein the second substrate includes another protrusion in an area corresponding to each of the plurality of conductive portions, the protrusion protruding toward the liquid crystal layer.

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30. A liquid crystal display device, comprising:
a first substrate, a second substrate, and a liquid crystal layer provided between the first substrate and the second substrate;

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wherein:

a plurality of picture element regions are each defined by a first electrode provided on one surface of the first substrate which is closer to the liquid crystal layer and a second electrode provided on the second substrate and 20 opposing the first electrode with the liquid crystal layer.

interposed therebetween;

in each of the plurality of picture element regions, the liquid crystal layer is in a vertical alignment when no voltage is applied between the first electrode and the second 5 electrode; and

in each of the plurality of picture element regions, the first electrode includes a plurality of openings, a plurality of generally star-shaped conductive portions each having four acute corners, and a plurality of connecting portions each 10 for connecting four conductive portions of the plurality of conductive portions to one another via the corners; and

the second substrate includes an opening provided in an area corresponding to each of the plurality of connecting portions.

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31. The liquid crystal display device of claim 30, wherein the second substrate includes another opening provided in an area corresponding to each of the plurality of conductive portions.